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ABSTRACT

Five widely-held myths about computer-assisted instruction (CAI) are exposed: 1) the teacher is the total instruction, 2) the CAI computer is designed for instruction, 3) there is one best CAI language for computer usage, 4) the biggest cost of CAI is machinery, and 5) a lack of learning materials exists in CAI. A framework for understanding, conceptualizing, and integrating major educational functions via information management systems (IMS) is proposed. IMS has the following primary functions: information retrieval of administrative and institutional data; training requirements for personnel; and computer support of instruction via computer-managed instruction (CMI), CAI, and learning simulation. (JY)

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CAI CENTER

TECH MEMO

CAI MYTHS THAT NEED TO BE DESTROYED AND
CAI MYTHS THAT WE OUGHT TO CREATE

Duncan N. Hansen and Barbara Johnson
The Florida State University

Tech Memo No. 38
June 30, 1971

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In terms of substance, these reports will be concise, descriptive, and exploratory in nature. While cast within a CAI research model, a number of the reports will deal with technical implementation topics related to computers and their language or operating systems. Thus, we here at FSU trust this Tech Memo Series will serve a useful service and communication for other workers in the area of computers and education. Any comments to the authors can be forwarded via the Florida State University CAI Center.

Duncan N. Hansen
Director
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ABSTRACT

Five myths about computer-assisted instruction are persistent and confusing, especially to educational leaders attempting to understand computers and education. The five myths destroyed in this paper are a) the teacher is the total instructor, b) the CAI computer is designed for instruction, c) there is one best CAI language for computer usage, d) the biggest cost of CAI implementation is machinery, and e) a lack of learning materials exists in CAI. This paper offers a framework for understanding, conceptualizing, and integrating major educational functions via information management system (IMS). The proposed IMS has the following primary functions: a) information retrieval of administrative and institutional data, b) training requirements for personnel; and c) computer support of instruction via computer-managed instruction, computer-assisted instruction, and learning simulations.

CAI MYTHS THAT NEED TO BE DESTROYED AND CAI MYTHS THAT WE OUGHT TO CREATE

Duncan N. Hansen and Barbara Johnson

There are five myths about computer-assisted instruction (CAI) that are persistent and confusing, especially to educational leaders attempting to understand computers and instruction. Whether the myths are passing controversies or vital issues, they continue to obscure basic comprehension. But, as in all myths, there is an element of truth in the fantasy. By first examining the myth and then locating the truth, the basic challenge underlying the mythology can be discovered. The primary challenge is to discover to what extent computers can be applied in education.

To ascertain the extent of application possible, there must first be explored the total concept of a computer-teacher-student complex. Underlying this complex there must be an information management system (IMS) which includes components of instruction, counseling, management, and resource allocation. Before examining these IMS components and their framework, we must destroy a few myths. Tilting at windmills is, after all, an honored academic pasttime--and a decided pleasure.

The five "windmills" are:

(1) The teacher is total instructor;

(2) The computer is designed for instruction;

(3) There is "one best language" for computer usage;

(4) The biggest cost of computer implementation is machinery; and

(5) A lack of learning materials exists in CAI.

Myth one: the teacher is total instructor. This concept was asserted by Stolurow (1961) a few years ago. While the purpose here is not to malign or diminish classroom teachers, the role underlying this concept must be questioned. Is the teacher--or can the teacher be--the total source of instruction in the learning process? Probably not. There are many equally, or in some cases more, powerful agents of instruction. Such significant sources of information as the television that is an ever-present view and voice, the music that "rocks" this culture, and the peer groups that set learning expectations and strategies--these determine whether students really want to learn or don't want to learn, or what is important and what is not. These sources are also integral to the human system called education. The truth is, then, that "nonhuman" computers are not in competition with teachers or even in any sense trying to model them. It is misleading to think so. Five years ago a tremendous mistake was made when the concept called "tutorial instruction" (IBM, 1967) was invoked. It would have been much wiser to say that computers should not be considered as attempts to replace teachers but rather should be thought of as resources to be contributed to the instructional process (Hansen & Harvey, 1969). How to contribute computer functions in an appropriate and effective way, a way that is economically reasonable, is the present challenge.

Myth two: The computer is designed for instruction. Terms such as computer-assisted instruction, computer-aided instruction, computer-aided learning, etc., have perpetrated this myth. Actually, no computer was originally designed to help in the instructional process. Computers were

always designed with some other purpose; a corollary thought struck people in the industry, as well as in the universities, that this device could be used as an instructional resource or as a research tool. In truth, all of the hardware, all of the software, behind computers have not received the necessary consideration, either from a pedagogical point of view, from an educational or societal point of view, or, for that matter, a scientific point of view (Muller, 1968).

If educators were going to try to design a computer system, they would need much higher density item file structures that are quite dynamic in order to carry on instructional dialogues. Developments in a CAI system or computer-managed instruction (CMI) system involve hundreds of items constantly being isolated, analyzed, and then restructured. While education is constantly re-working this mass of items it is not doing a great deal of numerical analysis. Yet most of the machines being used were designed primarily for numerical analysis. The interaction with the student and the computing operating system is fundamentally a symbol manipulating process, but most of these machines have not been designed to maximize symbol manipulation. They have, again, been far more oriented toward business applications dealing with large groups of numbers, with certain kinds of aggregate processes leading to numerical analysis.

Education requires its own special input/output devices. It needs terminals. Analysis of educational systems, not just in the CAI sense, but in the administrative data processing sense (libraries and so on), reveals that there is an extreme demand for inputting information and getting it out--but very little else happens to it other than simple structuring inside

the computer system. Most computing systems and computers have been designed the other way around--to do a great deal of structuring, a great deal of manipulation, internally. An improperly designed device is being used. Before the correct device can be ascertained, the concept "interactive reality" must be defined; that is, interaction with various kinds of information, concepts, and thoughts at the educational terminal. As this functional understanding evolves, education should be prepared to influence manufacturers to gain appropriate computer systems for education (Grayson, 1969).

Myth three. There is one best computer language. This myth probably stems from the "least efforts" orientation of the human race, which prefers to learn just one language. Learning is a chore. In truth, any of the computer languages can do the job, achieve the instructional goals that are set up. Obviously, some of the computer languages have certain virtues such as efficiency, or coding ease, or ease of learning, etc. (Frye, 1969). The same variables are true of human languages. Hence, man for well over five centuries has felt that it would be nice if all humans had just one language, to ensure maximal communication. Yet with each generation there are new dialects developing; there are regional dialects, and there are idiolects of each native tongue. Since in man's own relations he uses dialects, one can scarcely not expect them in the area of computer language.

Myth four. The biggest cost of computer implementation is machinery. This myth, like a number of other evils, is perpetrated by money. Because of the fundamental problem of educational economics, where tradition dictates making major capital investments mainly for buildings, the notion of invest-

ing largely in equipment and learning materials is rather new (Morgan, 1969; Alkin, 1969). There are actually two "truths" behind this myth. First, recent developments, such as the University of Illinois system, (Bitzer, 1968) seem to promise that in the future the cost of instructional terminals will be isgnificantly lower. In fact, if it goes like the rest of the economics of the United States, it is probably going to become far too inexpensive. Second, the most costly issue does not concern computers. It involves the training of professionals. In analyzing cost factors of almost any CAI project, the vast majority of money goes toward training people, not computer support. Of course, the computer purchase should be considered for its long range implications, wisdom of investment, and continuity. But the problem that commands more attention is simply one of finding the right people to train to use this very powerful computer resource in a reasonably wise way.

Myth five: A lack of learning materials exists in CAI. This transitory problem stems largely from the tendency to take too many analogs from the publishing industry or the prior work in programmed instruction (Mitzel, 1967). The resultant confusion centers around appropriate instructional models for appropriate impact on the student. There is actually a great deal of learning material available for computer usage. The Indicom project alone (Waterford, 1968) has probably generated 500 to 1,000 instructional hours. So the issue is not really the amount of learning materials; rather, what is the conception behind these CAI learning materials? Can there be a comprehensive concept of computers in education, a concept that will shape activities and energies so that they are not misguided or lost investments, especially in learning materials development.

This final myth has directed us to the challenge underlying the whole confusion created by the five myths. Given that we can understand the educational needs the computer might be able to answer, the need for information handling that would aid administrative decision-making, and the need to train people to use computers for scientific and business computations and the support of instruction would naturally follow. But to understand the nature of the computer application which will answer those needs is a major area of bafflement, especially for educational administrators and lay public. The purpose of the following presentation is to offer a relatively simplistic framework by which most of the major educational functions can be understood, as well as conceptually and operationally integrated. This integration can be achieved through the concept of an information management system (IMS) (Alcorn, 1966). Implied in this major purpose is a corollary thesis; namely, that the educational world does not need more sophisticated electronic equipment, but rather more trained personnel to better use the existing computer technology.

IMS

As stated above, an integrated computer approach to educational functions ought to be an information management system. The information management system includes at least these primary functions: (a) information retrieval of administrative and institutional data, conventionally referred to as educational data processing that allows for appropriate planning and decision-making; (b) training requirements for personnel to have a career in computer activities; and (c) use of computer support of instruction via computer-managed instruction, computer-assisted instruction, and learning simulations.

Administrative Functions.

It seems apparent that administrative data are only useful if they are retrieved in formats that provide a meaningful basis for decision-making or planning. The subcomponents within an administrative information retrieval system, then, cover such areas as fiscal transaction, property, facilities, scheduling, libraries, etc. In fact, it is highly possible that within a decade all of the administrative information retrieval functions can be put on a real time access basis. In other words, each of the principal decision makers within an educational institution would have a terminal, sharing use of computer time with other administrators. Availability of data files would probably be arranged according to administrative role, i.e., kinds of decisions, role, status. This would prevent overexposure of information that should in many cases remain under strict constraint.

But the important point here is the advantage that almost instantaneous reports would afford to educational decision making and planning. At present, these processes are dictated more by tradition than by rational empiricism.

This innovation implies a commitment to the training of administrators, so that they would use such information in a wise and judicious manner. For example, the health center at a large university discovered that 65% of its facilities and its manpower, doctors and nurses, were being used by 8% of the students. This 8% was termed high-users--of a prepaid health insurance plan. Why are they high-users? What are their characteristics? No one knows; all that's known about the high-users are their names. If there had been a reasonable information management system, not only could the problem have been identified but something

could have been done about it (Granger, 1967). As this society progresses to a prepaid health insurance scheme for all groups, the same problem seems to be occuring on a much larger scale. Thus, what we learn in the confined microcosm of an educational institution's health center could have implications for the whole of society. Rather than being constant listeners to society, perhaps educators can have something useful to say to it.

Career personnel. The second function of the management system, training requirements for careers in computer activities, calls for some far-sighted planning by educators (Marker & McGraw, 1967). The computer is without a doubt the most powerful logical thinking type of machine and system that man has ever created. It will be the source of one of the biggest vocational careers during the coming decade. Its problem-solving abilities have yet to be fully tapped. Therefore, there is a very strong argument to be made for the computer language as the most instrumentally important language that a school child can learn. Its instrumental payoff would be of far more benefit to school children and graduates than any other type of language they could learn. The importance of this possibility is being misgauged and that is an unfortunate oversight. Computer language should be included within a total approach of thinking about an information management system.

Computer support of instruction. In the total information management system, computer support of instruction has three subareas: computer-managed instruction, computer-assisted instruction, and learning simulation.

The rationale for presenting CMI first is a growing awareness, at least to those working in the area at Florida State, that this instructional

mode offers the most cost effective model in terms of its use of computers (Hagerty, 1969; Gallagher, 1970) as well as the highest potential for subsuming the other two types, CAI and learning simulations. Computer-managed instruction can be defined as an automated approach to individualized instruction that implements the functions of: (a) diagnostic evaluation with learning prescriptions; (b) the limited use of CAI for drill and practice or conceptual enrichment; (c) counseling of the students as to adaptive learning strategies and appropriate career development; (d) the development of a scheduling system for optimal match of students with learning resources, which include not only the computer but also other types of media devices including teachers; (e) learning simulations; and (f) the development of an appropriate student instructional record scheme which shows the educational process working on a day to day basis.

Rather than encode the learning materials within the computer system, as does CAI, CMI depends upon the availability of a far richer resource of conventional printed and multi-media materials. CMI uses the capability of the computer to manage the progress of the student through a particular course of instruction, testing at many points using CAI techniques for remedial or enrichment purposes. The resulting performance data base provides for the constant creation of more appropriate versions of the instructional process. A number of projects have used CMI in their operation, such as Flanagan's Project Plan (Flanagan, 1968), Coulson's work at Systems Development Corporation (Coulson, 1967), and O'Dierno's work at New York Institute of Technology (O'Dierno, 1968). In these projects students are guided to their learning materials based on progress information supplied by the computers to their teachers. Student instruction and testing are all performed with conventional paper and pencil procedures and the data

are fed through the computer via optical scanner. In turn, reports are supplied to the teachers of the students in terms of some kind of hand carrying or mailing scheme.

In the FSU approach to CMI, the majority of the diagnostic evaluations and the learning prescriptions that occur within a computer terminal-oriented interaction between the student and the CMI system provide three significant features. It allows for the inclusion of CAI techniques and learning simulations when desirable. It has the virtue of insuring that students are responsible for correctness of information both going in and coming out of the system. It allows more facilitated feedback so that the student receives his next learning assignment immediately, as opposed to waiting 24 hours or more.

Diagnosis and prescription. The individualization process under CMI is primarily based on an operational understanding of diagnostic evaluation and learning material prescription techniques offered via an interactive terminal. With the terminal interaction, such multiple dependent measures as error rates, error patterns, latencies, and the methodological techniques of sequential testing and learning optimization models can be just as readily applied here as they are in CAI. (Hansen, Brown, O'Neil, Merrill & Johnson, 1971). Hopefully, these will lead to a better representation of the diagnostic evaluation and learning prescription process for each child. In turn, CAI techniques, that is the encoding of actual learning materials when deemed appropriate, can be utilized within this approach. CAI can provide improved dialogue in regard to learning relationships, especially concerning those among behavioral objectives utilized within a course. Experience is demonstrating that most students cannot grasp behavioral objectives, that they need some dialogue, and some examples, to clarify the objectives. CAI can also provide a dialogue in regard to adaptive strategies

to be employed by the student--some of the good, rough-and-ready kinds of ways of getting through the course that other students have suggested and CAI can offer for consideration. And CAI provides for conceptual remediation and drill and practice on algorithmic learning processes.

The particular advantages found in CAI at the FSU Center have primarily dealt with the fact that for those students who are not coming up to normative standards, the CAI seems to have its greatest payoff. This, in the elementary school, is in terms of providing simple things like arithmetic drill and practice. In high school and college, for students having difficulty in physics, or chemistry, or psychology, it is giving them an opportunity to get significant practice with feedback on homework problems. Evidence indicates that homework is highly beneficial, yet the entire educational spectrum appears woefully deficient in offering students sufficient practice opportunities. CAI can offer students, even on a voluntary basis, these opportunitites to practice terminal behaviors and to get feedback.

A study just being completed at Florida State looked at the particular kinds of operations or pedagogical paradigms in a fairly complex and difficult set of mathematics material dealing with Boolean algebra. The materials indicated that the student has to learn a definition, and learn an algorithm, and then put those together to do something called a proof. Mathematicians consider all three of these important. In terms of giving feedback on these fairly difficult materials, four different types of time delays were selected. One was immediate feedback, which means approximately half a second to a second. One was systematically delayed 10 seconds, one was given at the end of the session (typically 50 minutes), and the fourth

group was given feedback after 24 hours. Surprisingly, preliminary analysis shows that the end-of-session group is running about 15% better, demonstrating that, with the many kinds of educational content, different requirements, differential student adaptation and entry behaviors, immediate feedback might, in fact, be very detrimental in comparison to giving the student an appropriate amount of reflection time. If this study holds up under replication, its implications for the educational world can influence methods of instruction, and its implications for design of computer equipment are even more dramatic. Designing hardware that can wait for response, or accumulate responses, can conceivably save money.

Counseling. In CMI, students can continuously be given opportunities to overview CMI courses and to gain information regarding their progress. They can ask questions about learning problems, adjustment processes, and their concerns about their future careers. This last is a kind of question that students appear very concerned about. Since all of these questions are important from the student point of view, CMI counseling activity relieves many of the demands on the human counselor or instructor within the system (Cogswell & Estavan, 1965).

Scheduling systems. The CMI system can be provided with a scheduler much like that of an airline, that matches human resources with learning materials in an appropriate and, hopefully, optimal manner. This appears to be, basically, a utilization of learning resources, but a larger aspect is perhaps more important. Through the development of an overall student records scheme, monitoring can provide a good empirical basis for rational judgments about how to improve the coordination of the human element with particular books, film, or other resources. That is, through

monitoring and revising, perhaps a better, or even a best, coordination can be accomplished of learning materials with students, counselors, teachers, researchers, Title III people, and even the representatives from the state departments of education.

Learning simulations. Learning simulations is a new topic in many ways. (Boocock & Schild, 1968). As educational institutions benefit from the more cost effective approaches of CAI and CMI, it seems reasonable that additional instructional enrichment should be offered through the technique of learning simulations. This involves the use of time compression techniques and decision role techniques to provide the student with the opportunity to learn and play the role of significant participant. For example, it is quite possible to provide the role and decision-making aspects of an executive of a business firm that proceeds through a 20-year time cycle within an instructional period of four hours or less. One simulation of this type has been developed at Florida State (Hansen & Harnum, 1970), as well as by Coleman and others in a similar form, providing for three parameters in the operation of a beer corporation. One parameter is for an inflation cycle, one is for a depression cycle, and one is for a normal business type of trade off. All of these are in terms of making business judgments, such as how much beer to produce, how much to spend on advertising, how much to enhance the distribution system, and what will be the outcome be, for this particular three month cycle? Students who take part in the simulation appear to be remarkably intuitive, and show great conceptual development in perceiving what happens after they operate through a two to four year depression, and then go into a very affluent time. They seem to experience a "viola" effect, and a tremendous fascination.

Another example of a learning simulation is one attacking the problem often addressed in social studies: cultural frames of reference. The diplomat game puts the junior high level student into the role of a diplomat, an American ambassador, in five countries making eight decisions in culturally difficult situations. The "ambassador" immediately gets feedback from four different frames of reference: how the people in that country feel about his decision, how the U.N. reacts to it, how Washington views it, and how his fellow diplomats regard it. These reactions are most often in conflict. It seems relatively clear that the importance of cultural frames of reference and the fact that conflicts come at times from these differences are able to be gained intuitively within as short a period as one hour.

Another very relevant problem that the CAI Center is attacking is pollution. Simulations now being developed include modeling an estuary, control of air pollution. The student deals with how many people he allows to live around the estuary, dumping sewage and pollutants into it, and he looks at the life and death cycle of the marine life inside the estuary in terms of each year of growth. Being a reasonable though not perfect modeling experience, it allows the student to make certain kinds of policy decisions about density of population and its effects on marine life, and, hopefully, provides him with some intuitions. The air pollution simulation will allow the student to deal with the control of such agents as cars and factory smoke and house coal and population density, again in terms of what this does to environment.

The important point is that learning simulations are an extremely promising area for this coming decade. Educators who come to grips with

using this technology in this enriched way can, preliminary findings indicate, turn students on to a new way of learning. (Nesbitt, 1968; Harvey, 1970).

Computer education costs. Optimism, in terms of cost, is supported by the efforts of competent people such as University of Illinois (Bitzer, 1968) personnel, working on a very large system that is hopefully going to operate at 30 cents per terminal hour. At Florida State, the system under development (Hansen, et. al., 1971) with perhaps not the most sophisticated or desirable but a highly workable terminal, is anticipated to operate for about 20 cents an hour. Costs are very serious, and if computer education cannot be cost effective, then it is nothing more than a toy for recreational purposes. But a few simple statistics indicate that this is not so, that computer education can be cost effective. In dveloping FSU's college physics course, (Hansen, Dick & Lippert, 1968), the CAI cost in terms of its development ran slightly over $4 per instructional hour. This was amortized over a fairly large number of replications, a realistic situation because the physics students continue to use the materials profitably. Operational costs for the fully automated instruction, with no instructor involved, ran $1.79 per instructional hour. Instructional development cost is now slightly less than $1 per instructional hour and actual computer time comes out at 59 cents averaged over the 50 hours. This is in a university where instructional costs are running close to $1.80 per instructional hour on the average, and fluctuating widely so that in laboratory courses it is close to $8.00 per hour. In some mass introductory history and psychology courses it is in the 50 or 60 cent range.

The important point of these statistics is that they argue that the immediate wave of the future can very well be in CMI. The broad conception of fitting CMI within an information management scheme could take care of many of the significant instructional applications of computers, such as learning a second language, or rational planning and rational decision making within the university or total educational enterprise. If education takes the broad viewpoint of diagnosing its total information requirements, and thinking of instruction as providing information at the right time to students, getting responses, and giving feedback about the responses, then computers in education can in fact enhance and look forward to a much brighter and far more effective educational process.

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